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also by stimulating the search for new elements and the efforts to ascertain the true relation of those already known. In this sense the present year may well mark the beginning of a new era in chemical discovery.

H. N. STOKES.

WASHINGTON, October, 1895.

ECONOMICS OF ENGINEERING PUBLIC WORKS.

It has become almost proverbial that the inhabitants of new countries are in many respects lavish and extravagant. Our Puritan forefathers were undoubtedly the most rigorous and economical people that ever faced privation and hardship, yet it can hardly be gainsaid that their descendants have lost that characteristic of frugality to such an extent as to make the American people distinguished for extravagance and prodigality; notably so in this nineteenth century. As a people we have not spent our wealth on the fine arts, but on silks and velvets for clothing, on diamonds and jewelry for adornment, on luxuries in food and drink, and in similar indulgences of a low order, and we are now beginning to feel the evil results of this course of action.

This lavish expenditure of money has been made possible by the great accumulation of wealth resulting from the natural resources of the land, the wealth of the soil, of the forests, of the mines, and from the labor and frugality of the pioneers. We, of this generation, not only have felt no need to practice the economies familiar to other countries, but we have been impelled by the consciousness of our national and personal possessions to make use of them in what has often been vain and extravagant display.

Then again, this general success in the battle of life has made individuals self-reliant, or rather has prevented that feeling of the need of coöperation which only lately has shown signs of existence. There

was a time when men rose unaided to the top round of financial success, made their own fortunes, and spent them as their tastes dictated; individuals hired individuals, and laborers worked for this man or for that, as fancy or personal preference led them; but not now. By means of coöperation and combination with others, man is enabled to have advantages which, as an individual, he cannot secure; for we have begun to act on the principle that, while one man's opinions may be ignored, there is power in the expressed wish of numbers. Trusts and brotherhoods are alike in trying to secure some advantage for their individual members to the exclusion of the rest of the world. Man has reached a point where he sees that to benefit himself he must be willing to help a few others as well. One step has been taken away from individualism, but only one, and that a short one. Let us look at some instances of corporations and associations seeking their own advantage at the expense of the public good. This is sometimes done wilfully, in the face of public needs and desires, and sometimes through blindness and ignorance.

There are in the United States thousands of miles of railroad which have been uselessly built. The money for their construction has been practically taken out of the store of the world's wealth and literally buried in the ground. They have been built either by shortsightedness or by knavishness on the part of a few, and can only be maintained by a higher rate on all railroad business, and a correspondingly increased tax on all who use the railroads. No one would hesitate to say that were the New York Central Railroad, for example, to have all the freight business between New York and Buffalo, instead of having to divide with its competing roads, the rate per ton on freight would be greatly lowered and yet a working profit be maintained. Aside, then, from the local business, which

could generally be more economically managed by feeders than by trunk lines, competing lines enforce higher rates for the service rendered. Had a proper regard for public economy been maintained the West Shore Railroad, for instance, would never have been built.

Now look at the management of our municipal affairs. Water pipes under the care of one commission are laid in one trench, gas pipes under another management in a second trench, and so with the sewers and the steam pipes, and the conduits for wires and for other purposes. Each company is responsible for its own ditch and its contents, but the cost of the trench is, in each case, added to the cost of the service rendered, and the community has to pay for the many managements and their lack of coöperative understanding. It is not an unknown thing after a town is well paved to have the pavement ruined by the subsequent laying of water and sewer pipes, with the additional expense of repaving the street over the trench. Were all pipes put together in a suitable and accessible conduit, paid for by the managements of the different pipe lines, and were the conduits built before any of the trenches are dug, a certain net gain to the community would ensue. Conduits could, in most cases, be built for less than the total expense of the trenches, and could be constructed in the streets of our large cities, thus avoiding the dead loss incurred whenever the streets are torn up for repairs.

Another instance is found in our colleges and universities, where useless duplication, arising from petty jealousy and departmental rivalry, results in direct loss to the institution. One professor delivers a lecture on iron ore, as part of the course in geology, and another, lecturing on the strength of materials, goes over the same ground. One department buys a machine to test the strength of boiler plates; another

invests in one to test bridge rivets, and another in one to test building stone; while a single machine would serve all three departments were there some authoritative head to make proper arrangements.

Our elective machinery is run in the same spendthrift way. City and National elections come at different times, and the cost to the country is doubled in consequence. In November a Presidential election is held, and the following Spring the same big engine—inspectors, clerks, halls, etc.—must be put in motion, and run a whole day for the purpose of electing a school trustee or a road commissioner. With our taxes it is the same story. In February the assessors make out lists, perform all the necessary work and the State tax is collected at great expense; in June the same outlay, both of time and money, is again necessary to collect the city tax; while, were both done at the same time, nearly half the labor and expense could be saved.

Instances could be cited almost indefinitely to show that we continually spend a great deal of money to no purpose, money which does not add to the store of the world's wealth, money which, so far as any lasting good or any visible result is concerned, is absolutely thrown away. We have grown up with it, and it seems natural and necessary to us. Our vision is limited, and provided the thing to be done is done, we do not concern ourselves as to whether, or not, it is accomplished in the most economical and altruistical manner possible. New ways are being forced on us, as they have been on older countries, and as a nation we are bound to consider the questions of the hour in a broader and more communistic fashion than any individual, who weighs only the chances of his personal advantage, would do. It does not follow, that we, as a people, are not capable of improvement because there are instances

where, as a people, we have allowed ourselves to be imposed upon. The history of no other nation is so full of examples of genius in adapting the means at hand to secure required ends. Bogie trucks, pin-connected trusses, timber trestles and bridges were all called into existence by the necessities of work, and by the American genius in employing the material at hand. The modern steel construction in city buildings comes under the same head. A study of the patent office records proves that we are extravagant, not because we are incapable of developing methods, but because it has not been necessary for us to be otherwise. This seems to point to the fact that we have become accustomed to care only for ourselves and our private interests and are neglecting public economies.

There are, however, growing evidences of progress in this direction. The Interstate Commerce Law is designed to restrict railroad charges between non-competing points to what shall be reasonable rates for the service rendered. Railroad corporations can no longer obtain franchises to construct lines parallel to existing lines, unless it is clearly shown that the traffic is too heavy for one road. Four States of the Union now refuse to give the right of eminent domain to railroads, as has been done in times past. Even to obtain a franchise for an electric street line it must be shown that there is a public demand for its construction. Within the past three months the Supreme Court of New York has confirmed a decision of the State Railway Commission to the effect that no electric road may be constructed parallel to a railway, unless it is proved that public necessity and convenience require it. The Courts held that exorbitant rates on the steam railroad were to be avoided by application to the Railway Commission, and redress had through them. The public has an inherent right, however, to the best service for the least money, and

if trolley lines can give better service at lower rates than the steam roads, public economy demands their construction and use.

Deep water canals, which are awakening so much interest at present, afford another example. Heavy and bulky freight of certain kinds can indisputably be carried more economically by canal than by rail, and yet the railroads keep up a bitter competition for that class of matter, and have even been known to carry freight at less than cost in order to force out of competition the canals running along their line of way. It would be far better were the work of the railroads restricted to the transportations of perishable matter and other things whose rapid delivery is important, and all else entrusted to the canals, whose operating expenses, even with the interest on the original outlay, are generally enough smaller to make a considerable difference in the cost of transportation. The possibility of carrying freight from New York to Chicago means the possibility of carrying it from Europe to Chicago, and means also saving to the community of the cost of reloading in New York. A deep water canal from Chicago to New Orleans would mean a cheap water connection between the North and the South, and again to the Nation the amount saved on freight.

In New York a great step has been recently taken in the acquisition by the State of a quantity of land. This act of remarkable foresight is a wise provision for future citizens. New Jersey has shown equal wisdom in reserving her mountainous and water-bearing country as a gathering ground, that all her cities may have a pure and unlimited water supply.

Boston, moved, to be sure, by her own immediate needs, is about to offer to thirty or forty cities in that vicinity the opportunity to share in a large enterprise, by which each may secure good water at reduced

rates. Some years ago, Boston, in the same manner offered to the cities along the Charles and Mystic rivers a plan for the disposal of their sewage, as, by thus joining forces, the cost to each would be greatly lowered. Many examples of the recent tendency towards municipal economy might be enumerated; among others the modern sentiment on the value of street railroad franchises; the feeling that gas and water should be furnished to citizens at moderate rates; for no private company has the right to demand more than a reasonable profit; also that it is the duty of the city authorities to exercise their right of jurisdiction in these matters. There are, too, signs of growing enlightenment in the direction of caring for waste. People are beginning to realize the dead loss incurred by mixing different kinds of garbage, some of which have a value. There are now many manufactories that use as raw material what, in time past, was regarded as waste product. We might go on to speak of the folly of individuals making dirt which the municipality must clean up; to the use of water meters, to prevent waste even where there is plenty of water; all these things go to show inclination towards more careful consideration of municipal economy.

Apply this tendency to the question of water supply, and make the maintenance of its purity a question of public economy. Water is not only a prime requisite of food, but it also acts as chief among our scavenging agents. In our water works it does double duty; it brings water for cooking, drinking and cleaning into our houses, and after being made foul and unhealthy it carries away with it most of the waste of our vital processes. The large streams of a country act in the same way as the water in the pipes of a house. They bring into a city supplies for its daily life, and they carry away the waste. Since, except for the city at the river's source, the stream

cannot serve both purposes, it must be decided for each stream which service it shall perform. This question should be settled by some authority, learned not only in the quality of the stream, and its inherent fitness for being used for either purpose, but learned also in the economic phase of the question. Would the community as a whole be better served by having, for example, the Passaic river kept, by the exercise of some authority, pure and wholesome for domestic purposes, or by allowing it to be made an open sewer, a proper place for the discharge of all manufacturing waste. Shall the stream in question remain throughout its length as pure as at its source, or shall it be avowedly given up to pollution, is a question to be settled, not by asking if any one city along its banks desires to use the water of the stream for drinking purposes, but by a determination of the needs of the community. Contamination, or that which renders a stream unfit for further domestic use, is caused by the introduction of manufacturing wastes and of human refuse, and in order to keep a stream pure these two sources of contamination must be avoided, either by keeping all such matter out of the stream entirely, or by requiring some process of purification which shall render them non-injurious. It seems almost inevitable that these waste products will sooner or later find their way into the stream. It has been proved that intermittent filtration, well and carefully managed, will restore polluted water to a pure condition, and the practicability of its use for large cities is now being tested in several places in this country. The economical question to be answered with reference to any stream whose water is to be used at any point for drinking purposes, is: should the polluted water be *made pure* in such quantities as are needed for a specific use, or should the stream be *kept pure* by prohibiting its pollution at any point; that is by re-

guring the purification of waste before it enters the stream. The general trend of modern legislation is towards the latter course, no doubt due largely to the influence of the increasing number of State Boards of Health; but why not make it a question of municipal economy?

If Newark, for example, wants her water supply from the Passaic river, whose waters are polluted, does it not seem absurd, speaking broadly, that she should be required to purify her supply of twenty million gallons a day when the pollution comes, perhaps, from one mill discharging only one million gallons? If one woolen mill on a stream causes pollution that obliges a dozen cities further down the stream to construct filtration works, provided they are to drink the water with any degree of safety, would it not be more economical to oblige the one mill to purify its comparatively small amount of waste before it is allowed to enter the stream, instead of permitting the pollution of the whole river? *Vice versa*, streams already devoted to the service of mills and manufacturies may better serve the general economy by continuing in that service; and the one or two cities can build filtration plants at less cost than that of purifying the wastes of all the manufacturies. Only a careful study of the condition of the communities along the banks can ascertain in which way the gain to the whole people is found, in which way public economy is best maintained.

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MARINE LABORATORY OF THE UNITED
STATES FISH COMMISSION AT WOOD'S
HOLE STATION, SUMMER
SEASON OF 1895.*

THE present 'Laboratory of Scientific Research' was constructed after Professor

*This has been an especially active season at the Government and Marine Biological Laboratories at Wood's Hole. At our request Professor Peck, who

Baird's designs in the year 1884, as part of the large building which serves the department of fish culture. This is, therefore, the eleventh season during which scientific research has been prosecuted under these conditions both by government patronage and by individual responsibility, and it is instructive to look back over these years and see how many well-known workers have been accommodated here, and of how much service these advantages have been to the learned institutions which they represent, such as Yale, Princeton, Harvard, Johns Hopkins, Columbia, and the University of Pennsylvania, besides a large number of smaller colleges both East and West.

There have been present at the Laboratory this summer thirty workers, representing twenty important educational institutions of this country, and one German university; four of these institutions are various high schools of the city of Chicago. These thirty have been engaged upon such a wide range of problems that only the more notable can be mentioned.

One piece of research, by Prof. H. V. Wilson, upon the sponges from the Gulf of California and the Galapagos Islands, collected by the U. S. steamer *Albatross*, under the direction of Professor Alexander Agassiz, has drawn our attention to the value of that side of biological work. Embryology naturally fills a large place here and two phases of it have been followed. The first, by Prof. W. Patten, deals with abnormal development in *Limulus embryos*. A certain small proportion of the eggs pass through the normal formation of the perfect embryo, only to then reverse the process and fade back to the original simple egg condition; or a double embryo may be formed, or a triple embryo in regular sequence, or one side of the embryo

has been in charge of the research work at the Government station this summer, sends to SCIENCE this informal report.